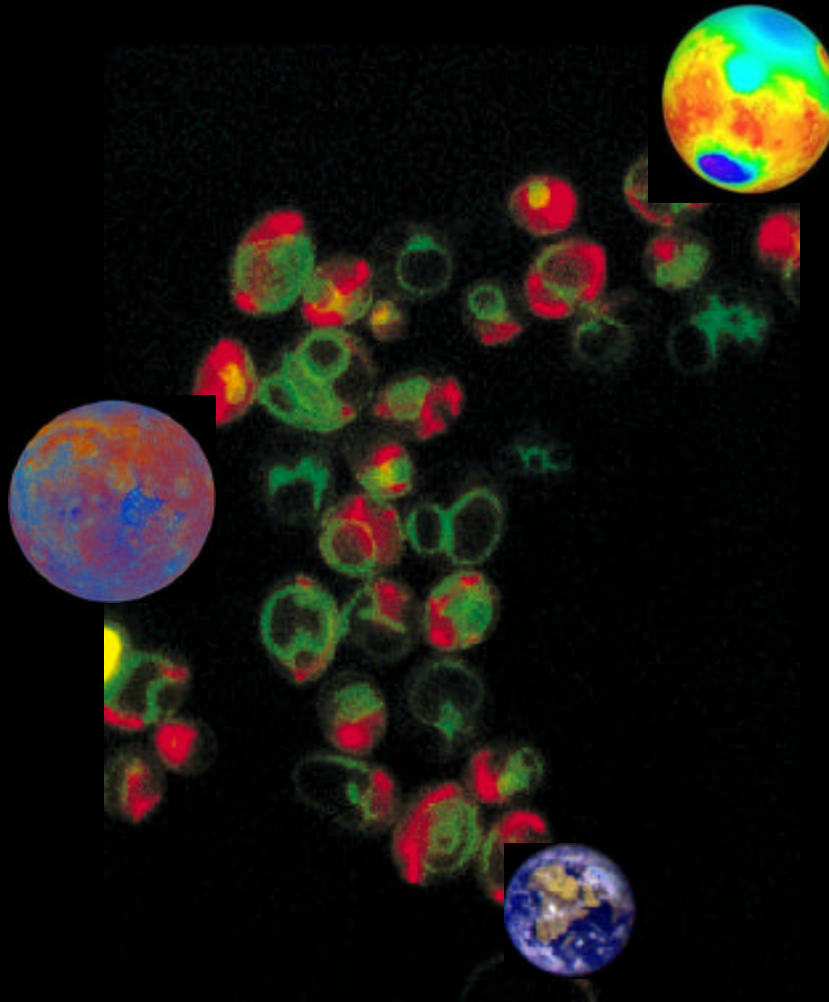
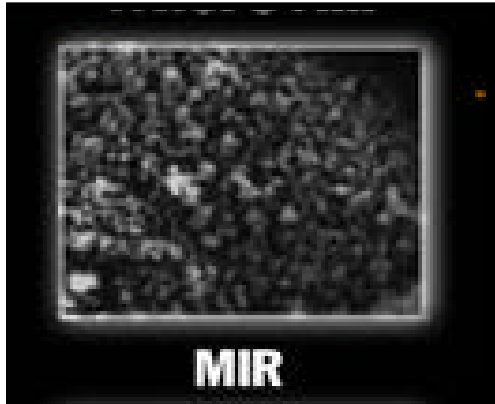


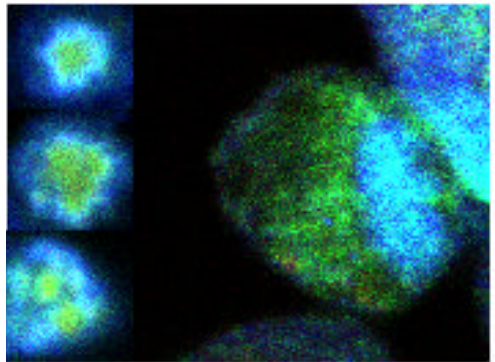
TRANSITIONS BACKUP CHARTS



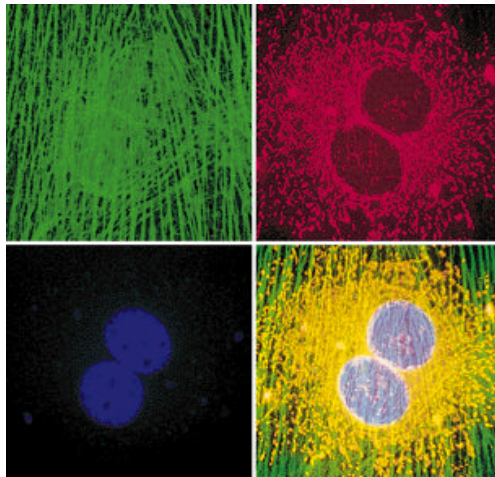
Foundational Assumptions



Physiological and structural changes seen in space can be traced to changes in gene expression. Today, the genome's message can be read with exceptional precision.

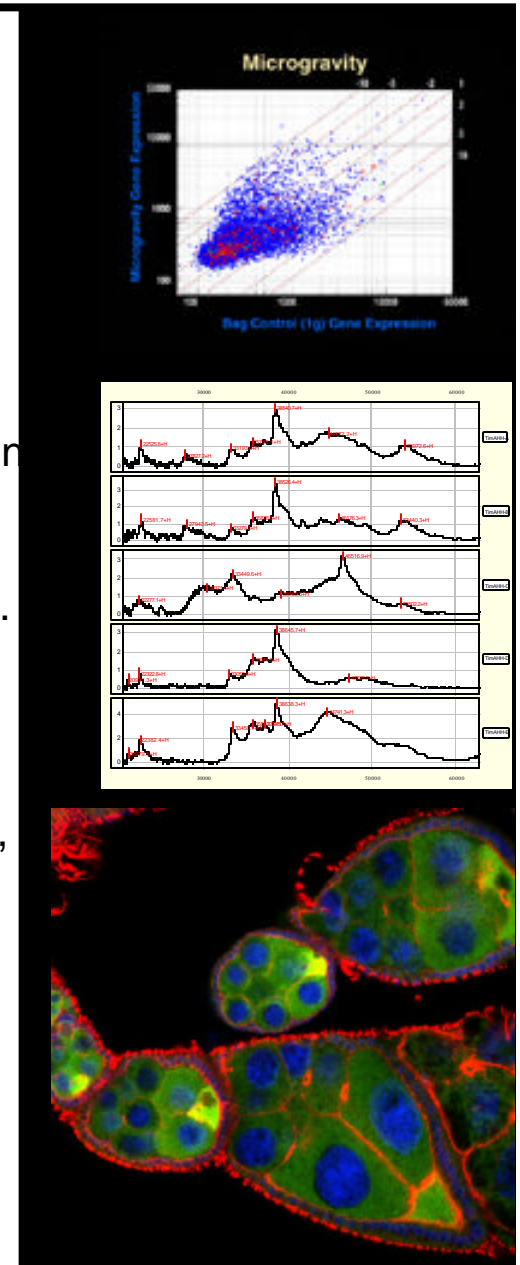


The change in gene expression is controlled in part by transcription proteins. We can detect these transcription proteins and confirm their movement from the cytoplasm to the nucleus.

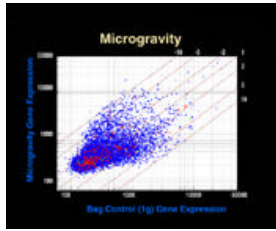


Genes direct the production of specific proteins. Using molecular probes, specific proteins can be tagged, and their abundance, distribution and dynamics determined.

We can trace this process at all levels of biological organization, in multiple species, over life cycles and generations in space.



Representative Capabilities	Molecular Biology	Life Cycles	Evolution and Ecology	Mission Payoff
	2002-2006	2007-2011	2012-2016	
Cell and molecular biology	Survey genomics, proteomics, metabolic, structural effects of representative small species	Survey biopsied tissues inflight of representative species for correlative genomics studies	Functional genomics of life cycles in space.	Identify root cause of space medicine problems; determine potential and biological cost of evolution beyond Earth.
Cell to organ Integration	Survey human and mammalian tissue cultures for space and Earth medicine applications	Variable gravity biology, moon, Mars, gravitational countermeasures	Human Countermeasures	Remove biological barriers to spaceflight and long term occupation of space
Complex organisms and mammalian life cycles	Functional genomics of biopsied tissues postflight on representative complex species	Functional genomics of full life cycles in space of mammals and complex species	Developmental Biology	Ability to establish colonies beyond Earth
Multiple generations	Start long term culture systems for decadal studies on microbial species	Multiple generation studies of plants, insects, fish and other species with short life cycles.	Bioengineered species for successful evolution beyond Earth	Ability to evolve beyond Earth



?
gene expression

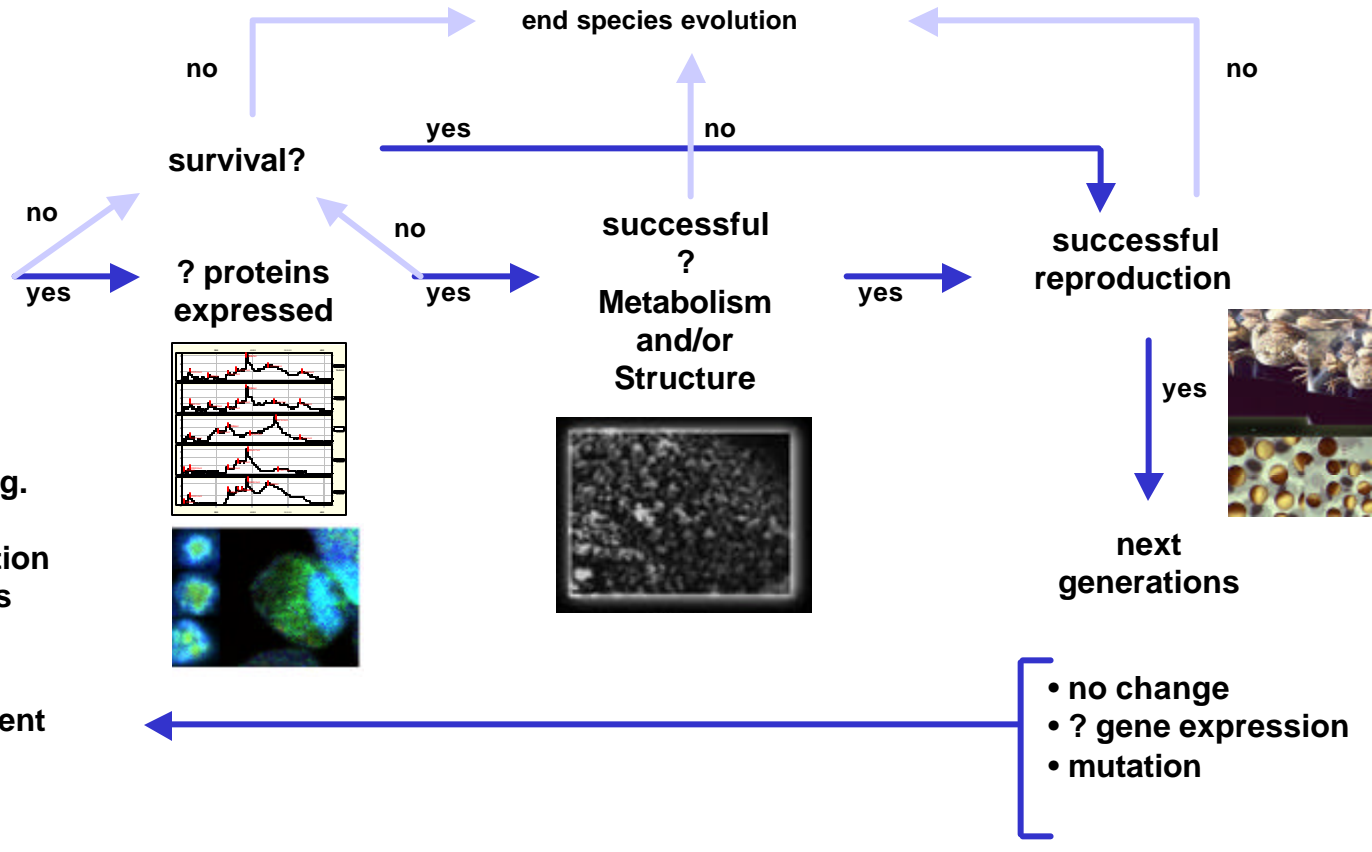
Signal e.g.
? Transcription
proteins

? environment

Leave planet of origin



planet sculpts life



Evolution of terrestrial life beyond Earth

*How much of this sequence
can be studied in space?*

All of it

Bacteria, yeasts, *Drosophila*, *C. elegans*, plants, fish
 Human and animal tissue cultures
 Cell lines
 Embryos
 Eventually human and mammal subjects

Time course, cell cycles, life cycles, *n* generations

Research platforms	Space ⇒	Δ organism/ environment interface	Signal ⇒	Δ gene expression	mRNA ⇒	Δ protein complement	⇒	Δ metabolism	Δ structure
Shuttle Cells, tissues, adaptation	Start experiment in space via freezing, dormancy adding nutrients in flight	- gravity - shear - density-driven forces - coriolis - turbulence - convection + radiation measured with sensors	Cell senses change and transcription proteins migrate to nucleus to turn on gene expression Measure via proteomics	Analyze whole genome microarray	Fix + refrigerate or Freeze @ (-80°C) Enables cDNA library	Freeze -20°C Snap freeze @ (-80°C), store @ (-120°C) ----- fluorescent proteins ----- analyses scale with available sample ----- correlate with gene array data		Substrates for different enzymes Time samples	Fix for electron, confocal, other microscopy
Early ISS Small organisms, life cycles, tissue aggregates				Use species where whole genome is known					
Later ISS Larger organisms, multiple generations, evolution				leverage and contribute to databases					
Planets									

Interesting Opportunities

- ✍ Piggybacks and Minutemen: NRA for postflight analyses
- ✍ Additional samples preserved on traditional investigations for genomics/proteomics/molecular probe/structural analyses.
- ✍ Evaluate hw nationally and invest in modifications to complement rather than compete with capabilities.
- ✍ Tissue archive program.
- ✍ Data mining program
- ✍ Correlative studies program.
- ✍ Free flyers, deep space bioexplorers
- ✍ Commercial partnerships and leveraging
- ✍ Fast response capabilities
- ✍ Requires support for in house ad hoc opportunities development.